STUDIES ON THE EFFECT OF CERTAIN INSECTICIDES ON THE BEET LEAFHOPPER WITH SPECIAL REFERENCE TO LIME-SULPHUR

BY

JOHN DONOVAN DE COURSEY

B. A., Louisiana State University, 1930
A. M., University of Illinois, 1937

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STUDIES ON THE EFFECT OF CERTAIN INSECTICIDES ON THE BEET LEAFHOPPER WITH SPECIAL REFERENCE TO LIME-SULPHUR[1]

Introduction

The virus disease of sugarbeets called curly top and transmitted by the beet leafhopper, *Eutettix tenellus* (Baker), has caused considerable crop losses throughout sugarbeet-growing areas in the western United States, at one time seriously threatening the sugarbeet industry.

The study of the residual action of dry lime-sulphur on the young of the beet leafhopper together with the action of other insecticides was suggested by Mr. J. R. Douglass, Associate Entomologist, of the Bureau of Entomology and Plant Quarantine located at Twin Falls, Idaho. In 1938, the author obtained a substantial reduction in nymphal populations, resulting from laboratory tests with dry lime-sulphur. In order to determine the causes of these population reductions, further investigations were carried on during 1939 and 1940 at the field experiment station of the Bureau of Entomology and Plant Quarantine located at Twin Falls, Idaho.

Methods

Throughout this investigation, sugarbeet plants used in the greenhouse studies were of the variety U. S. 12 with the exception that the variety U. S. 22 was used in the experiment on the fumigating effect of lime-sulphur. In the field tests beet plants of the variety U. S. 33 were used.

In all tests conducted with lime-sulphur, the commercial form of dry lime-sulphur was used. The pyrethrum used in the experiments with the lime-sulphur was a water-soluble extract.

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[1]The writer wishes to express his appreciation to the Bureau of Entomology and Plant Quarantine for their permission to publish this abstract and to the members of the field experiment station at Twin Falls, Idaho, for their most helpful suggestions and criticisms. The writer is also greatly indebted to Professor W. P. Hayes and other members of the Department of Entomology, University of Illinois, and Mrs. J. D. De Coursey.

The cages used in the work were of two types. A cloth-celluloid cage designed by F. R. Lawson of the Bureau was used for all tests involving the enclosure of an entire beet leaf. A cage designed by C. F. Henderson was used in the absorption experiments where each side of a green leaf was placed in a separate enclosure.

Nymphal leafhopper production was obtained by placing from five to ten female leafhoppers, depending upon the season of the year, in each cage and allowing them to remain for five days for the purpose of oviposition. The nymphs were counted when the majority of them were in the fifth instar. When it was necessary to determine the first and second instar nymphs, the head widths of anesthetized insects were measured and compared with the calculated head widths as determined by Harries and Henderson.

Sugarbeet plants were sprayed in laboratory experiments with an air pressure spray gun operated at forty pounds pressure until the leaves of the plants were dripping. Field beets were sprayed with a hand-operated pressure-sprayer strapped to the back of the operator.

Adult female leafhoppers were sprayed in small twenty-mesh copper-screen cages, tubular in form, which were hung on a circular rack that revolved on a turntable rotating at 26 revolutions per minute. The air-pressure spray gun was run at constant pressure and set to atomize a given amount of spray in the predetermined time allowed for each test. Twenty cages, each containing ten female leafhoppers, were sprayed in one operation. Immediately after spraying, the exterior of the cage was wiped with cloth to remove excess moisture from the screen and to prevent the insects from adhering. The leafhoppers were then removed with a pipette and transferred to cloth-celluloid cages enclosed in beet leaves, ten insects to each cage.

The nymphs of the beet leafhopper were sprayed in a blower apparatus designed by F. H. Harries of the Bureau of Entomology and Plant Quarantine, consisting of an electric blower having an upright intake pipe in which was placed a celluloid cage with screen ends containing the insects. The suction of the blower fan was used to draw the spray from the gun through the cage.

Lime-sulphur as a dust diluted with inert ingredients for comparison with other sulphur products was applied to sugarbeet leaves by means of a celluloid cylinder to the end of which a fine-mesh cloth was fastened as over a drum. The open end of the cylinder was placed over a leaf and the dusts were broken up and spread by rubbing them through the cloth at the top. In this manner dust dropped through the air onto the leaves in apparently even, finely divided particles.

Tests on the residual action of mixed sulphur and arsenical dusts were conducted by placing over each beet leaf a tin milk can which had been inverted and a hole one inch in diameter cut in the center of the bottom. Over this opening was fastened a piece of one-inch rubber hose eight inches long. To the free end of the hose was fastened a small funnel into which the dusts were applied in amounts of one gram each, by means of a separatory funnel attached to a compressed air valve.

The cloth-celluloid cages used in the work were tested for retention of fumes of lime-sulphur which might be a factor in nymphal mortality of the leafhopper. This was done by passing a continuous supply of air through the cages which enclosed beet leaves previously sprayed with lime-sulphur.

The repellent effect of lime-sulphur was tested by placing treated and untreated sugarbeet plants in opposite corners of a revolving cage. One hundred female leafhoppers were placed in each cage, twenty-five being introduced with a pipette through an opening above each plant in order that they would have an equal opportunity to go from one plant to another. Twenty-four hours after the insects were introduced, partitions were lowered, completely enclosing each plant. The leafhoppers on and in the vicinity of the plant were then counted and recorded.

Results and Conclusions

An investigation into the possibility that sugarbeets might absorb lime-sulphur showed that the material is not absorbed and translocated from one leaf to another in sufficient quantities to affect nymphal mortality when used at a concentration of 3° Baumé. Treated leaves gave a mortality of 100 percent, 99.7 percent of which died in the first and second instars, com-

pared with six percent dead in the controls. The untreated leaves, which had been protected by cellophane bags on the treated plants, gave a mortality of eight percent. Beet leaves were treated on both upper and lower sides separately without producing an increase in mortality on the opposite side.

The cloth-celluloid cages used in the work were tested for retention of fumes of lime-sulphur which might be a factor in nymphal mortality. A mortality of 99 percent in the first and second instars was produced by the insecticide with 16 percent mortality in the controls, indicating that fumigation was not an important factor in the reaction.

Tests on the repellent action of lime-sulphur when sprayed on leaves of the beet plants, using 1600 adult female beet leafhoppers, showed 51 percent of the insects in the vicinity of the controls and 49 percent of the insects in the vicinity of the treated plants, indicating that there is no repellent effect from the material.

Beet plants sprayed with lime-sulphur at concentrations of 0° Baumé (a trace), ½°, 1°, and 2° Baumé showed that even a trace of the material was sufficient to produce a mortality of 22 percent compared with 6 percent in the controls. The mortality at a concentration of ½° Baumé was 71 percent compared with the same controls and the 1° and 2° concentrations gave 97 and 98 percent, respectively, compared with four percent in the controls.

Female leafhoppers were found to oviposit as readily in treated leaves as in untreated, the reduction in populations being due to failure of the eggs to hatch on the treated leaves. The average number of nymphs per cage was 29 percent greater in the controls than in the group sprayed before oviposition, and 52 percent greater than in the group sprayed after oviposition.

In previous experiments nymphs of the beet leafhopper were killed in the first and second instars by lime-sulphur. Tests were also conducted to show its effect on older nymphs. The ranges in mortality for concentrations of lime-sulphur of from ½° to 3° Baumé for insects introduced in the third, fourth, and fifth instars were from 61 to 70 percent, with 14 percent in the controls, 31 to 48 percent with 12 percent in the controls, and 32 to

43 percent with 27 percent in the controls, respectively. These results indicate that lime-sulphur has a definite residual effect in increasing mortality of third- and fourth-instar nymphs, but has no appreciable effect on the mortality of nymphs after they reach the fifth instar.

The adults are not affected by the residue. Throughout the entire work adult female leafhoppers were placed on both treated and untreated leaves for the purpose of oviposition. At no time was the mortality on sprayed leaves found to be greater than that on unsprayed leaves.

The period of effectiveness of lime-sulphur at a concentration of 1° Baumé was tested. The material remained 90 percent effective for approximately three weeks after it was deposited on the leaves, under greenhouse conditions. The effectiveness of the material rapidly decreased after three weeks and was only 24 percent effective after five weeks time.

Tests with different oils, containing unsulphonated residues from 90 to 98 percent and having viscosities of from 52 to 115 seconds Saybolt universal, as spreaders for lime-sulphur, showed that they were unsafe to use on beets due to the heavy burning they produced on the leaves. Casein added to dry lime-sulphur as a spreader did not increase the efficiency of the insecticide.

The residual action of dry lime-sulphur dust containing different percentages of talc was compared with flowers of sulphur dust alone, flowers of sulphur dust and casein as a sticker, lime-sulphur at a concentration of 1° Baumé, and with soluble sublimed sulphur 3 grams in 300 cc. distilled water. All treatments produced significant mortalities with reference to the controls except where a high percentage of inert ingredient was used with lime-sulphur. The different dusts were found to be approximately equal in efficiency to dry lime-sulphur in distilled water at a concentration of 1° Baumé, which gave 98 percent mortality, although they do not adhere as well.

Lime-sulphur was used in a field of sugarbeets 265 feet long by 111 feet wide in concentrations of 1° and 3° Baumé using a total of 65 gallons of spray. One-half the field was sprayed a

second time after two weeks using approximately 30 gallons of spray. Counts were made of fifth-instar nymphs from individual beet plants. Statistical analysis of the results gave a mean difference for lime-sulphur 1° Baumé and the controls of 17.85± 6.38 and for lime-sulphur 3° Baumé and the controls of 26.55± 6.38. Each of these differences is significant and indicates that lime-sulphur was a factor in the reduction of the number of leafhopper nymphs present on the sprayed plants. The difference between the two concentrations proved not to be statistically significant. No appreciable difference was noted between the results with one application of spray and a second application.

A comparison of the residual effect of lime-sulphur 1° Baumé, with water-soluble pyrethrum and lime-sulphur 1° Baumé combined, at a concentration of 1 part pyrethrum to 200 parts lime-sulphur, showed a nymphal mortality of 78 percent for lime-sulphur alone compared with 70 percent mortality for pyrethrum and lime-sulphur combined, with only four percent mortality in the controls. Analysis of the data showed that the difference between the mortalities produced by the two sprays was not statistically significant and indicated that the addition of pyrethrum to lime-sulphur spray does not reduce or increase the residual effect of the lime-sulphur on nymphal mortality.

The contact action of lime-sulphur alone, and in combination at a concentration of one part pyrethrum in 400 parts 2° Baumé lime-sulphur, was compared with pyrethrum in water at the same concentration on adult leafhoppers with the result that an average of four percent mortality compared with three percent in the controls was obtained. This shows no significant increase in mortality due to the use of lime-sulphur. Pyrethrum and lime-sulphur combined showed a mortality of 62 percent while pyrethrum in water gave 65 percent compared with the controls mentioned above. A comparison of the percentage mortality brought about by the use of pyrethrum and lime-sulphur combined with that of pyrethrum in water did not give statistically significant results and suggests that pyrethrum is as active when in this combination as it is when used in water alone.

Tests with the same combination of lime-sulphur and pyreth-

rum on the leafhopper in different stages of development showed that the resistance of the leafhopper to the contact action of pyrethrum in lime-sulphur is greater in the adult stage, gradually diminishing in the nymphal instars to the weakest point in the first and second instars.

The effect of ageing on the contact action of pyrethrum in combination with lime-sulphur, one part in 400, was tested by spraying female leafhopper adults with the material immediately after it was mixed as well as two, four, six, ten, fourteen, eighteen, and sixty hours later. The results of these experiments showed no evidence that pyrethrum in lime-sulphur deteriorates within a period of sixty hours after the materials are mixed at the concentrations used.

A comparison of flowers of sulphur with micronized sulphur and combinations of the two dusts with arsenical dusts showed that severe burning accompanied the application of micronized Paris green with regular and micronized sulphur dusts thus eliminating these treatments. The following materials were tested for residual action on the nymphs of the leafhopper: flowers of sulphur one part and calcium arsenate four parts, flowers of sulphur two parts and calcium arsenate one part, and flowers of sulphur three parts and zinc arsenite one part, micronized sulphur, and flowers of sulphur alone. All treatments were significantly different with reference to the controls. Flowers of sulphur and calcium arsenate dusts were significantly lower in residual effect than all others. The remainder of the treatments were not significantly different as compared one with the other.

Pyrethrum in lime-sulphur, at a concentration of one part pyrethrum in 200 parts lime-sulphur in water, shows promise as in insecticide because the two may be mixed without detrimental effect to either material. The action of the pyrethrum kills all stages of the beet leafhopper upon contact and the residue of the lime-sulphur remains active on the beets for a considerable period of time, killing young nymphs shortly after they hatch from the eggs as well as causing many to die within the egg. The spray adheres better than dust and thus gives protection for a greater period of time.

VITA

The author, John Donovan De Coursey, was born April 1, 1905, in Indianapolis, Indiana, where he attended Ben Davis High School, graduating in 1923. He entered the University of Illinois in 1925, transferring to Louisiana State University in 1927, from which institution he received the Bachelor of Arts degree with a major in zoology in 1930. He enrolled in the Graduate School of the University of Illinois in 1930, attending part time while working in the capacity of Assistant Entomologist for the Illinois State Natural History Survey until the summer of 1932. The degree of Master of Arts in Entomology was granted by the University of Illinois in 1937. Since the summer of 1938 he has been employed by the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine, Beet Leefhopper Investigation Laboratory, at Twin Falls, Idaho. He is a member of the Association of Economic Entomologists and an associate member of Sigma Xi.

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3. Experimental infection of *Hyphantria cunea* with *Nosema bombyces*. Jour. of Parasit., Vol. 26, No. 2, April 1940, pp. 123-125 (Junior author with R. R. Kudo).